

Metrication is the process of introducing the International System of Units (abbreviated SI for *Système international d'unités*), the metric system of measurement, to replace the traditional or customary units of measurement of a country or region. Although all U.S. customary units have been redefined in terms of SI units, the United States does not commonly mandate the use of SI, making it, according to the CIA Factbook, one of three countries that has not adopted the International System of Units (SI) metric system as their official system of weights and measures, along with Burma (Myanmar) and Liberia

## **Mars orbiter**[\[edit source\]](#) [|](#) [edit](#)

The use of two different unit systems was the cause of the loss of the Mars Climate Orbiter in 1998. NASA specified metric units in the contract. NASA and other organizations applied metric units in their work, but one subcontractor, Lockheed Martin, provided thruster performance data to the team in pound force seconds instead of newton seconds. The spacecraft was intended to orbit Mars at about 150 kilometers (93 mi) altitude, but incorrect data probably caused it to descend instead to about 57 kilometers (35 mi), burning up in the Martian atmosphere.

## **Current use**

### **Daily life**

While most Americans have studied metric units at school, metric use remains low in daily life. Speed limits are almost always in miles per hour and road signs usually give distances in miles or feet. The BTU remains the common measure of heating and cooling, and clothing is measured in inches. Some of the more common SI prefixes are widely known, and are sometimes used with non-metric units. For example, computer memory storage capacity is measured in kilobytes, megabytes, or gigabytes, and digital camera resolution is specified in megapixels. Nuclear explosions are measured in kilotons and megatons of TNT. The letter *K* is commonly used to denote "thousand" (e.g., "She earns \$80K"). However, contrary to the SI system, this is often written with an uppercase *K* instead of a lowercase *k*. This usage has largely replaced the letter "G" (for "grand", used almost exclusively for money) and the Roman numeral *M* that was commonly used for "thousand" before the 1960s; in fact, the "M" has now come to denote "million" (e.g., "\$32.5M budget").

### **Weather**

Televised weather reports are given in Fahrenheit for dew point and air temperatures, miles per hour for windspeed, inches of mercury for atmospheric pressure (millibars are used only when reporting tropical phenomena such as hurricanes), and other customary units. In some states which border Canada, temperatures are described in both Fahrenheit and Celsius, as the broadcasts can be received in Canada, which uses Celsius, as well as for those who live in Canada who are visiting the U.S. or have just moved.

## Consumer and retail

Some U.S. consumer products come in rounded metric sizes. This appears to be increasing because of the international nature of manufacturing, distribution, and sales. A few products display the metric quantity first or more prominently. Some items are produced and sold in rounded metric quantities (e.g., Crest Glide dental floss is available in 35-, 40-, and 50-meter packages).

Perhaps the most common metric item sold is the two-liter bottle. Some supermarket chains also make their store brand soft drinks available in 3-liter sizes. Soft drink containers of 1 and 0.5 liters are sometimes sold alongside 12 fl oz, 16 fl oz, 20 fl oz, and 24 fl oz (355, 473, 591 and 710 ml) sizes. Wine is also sold in standard bottles of 750 mL, as in the rest of the world. A fifth of liquor, once one-fifth of a U.S. gallon, or 757 mL, is now commonly 750 mL, though it is still referred to as "a fifth." It is becoming increasingly common to find bottled water in half-liter and one-liter sizes, though 16 fl oz, 20 fl oz, and 24 fl oz sizes remain popular. However, attempts to sell 3- or 4-liter jugs of milk, instead of gallons (3.785 L), have been largely unsuccessful, and such bottles are almost never seen in the US.

Household products such as shampoo, mouthwash, and dental floss have begun to be sold in metric sizes, and PowerBars and similar products have always been sold (but not marketed) by the gram. Consumer-size photographic film is commonly sold in a 35 mm standard (24x36 mm negative), although print sizes and large format films are defined in inches. Digital camera sensor sizes are measured in an archaic manner indicating inverse fractions of an inch, as a 1/1.6" sensor is larger than 1/2.5" sensor. However, lenses have always been sold in terms of focal length in millimeters (e.g., average natural human field of view is a lens with 50mm focal length for 35mm film). Electric power ratings are always provided in Watts and electric current in Amperes, which are metric units.

Sometimes metric and non-metric are combined on the same product. The standard method for sizing tires combines millimeters for tread width but uses inches for rim diameter. Tire inflation for a typical passenger car is 30 psi (pounds per square inch), which is also given in its metric equivalent (207 kPa, or Kilopascals). In lighting, light bulbs use eighths of an inch for bulb diameter and full inches for fluorescent tube lengths, while the socket is always in millimeters (for example, the standard "medium Edison screw" is E26).

Sample label for  
Macaroni & Cheese

<b>Nutrition Facts</b>	
Serving Size 1 cup (228g)	
Servings Per Container 2	
Amount Per Serving	
<b>Calories</b> 250	Calories from Fat 110
% Daily Value*	
<b>Total Fat</b> 12g	<b>18%</b>
Saturated Fat 3g	<b>15%</b>
Trans Fat 3g	
<b>Cholesterol</b> 30mg	<b>10%</b>
<b>Sodium</b> 470mg	<b>20%</b>
<b>Total Carbohydrate</b> 31g	<b>10%</b>
Dietary Fiber 0g	<b>0%</b>
Sugars 5g	
<b>Protein</b> 5g	
Vitamin A	<b>4%</b>
Vitamin C	<b>2%</b>
Calcium	<b>20%</b>
Iron	<b>4%</b>
* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.	
	Calories 2,000 2,500
Total Fat	Less than 65g 80g
Sat Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g

Sample US Nutrition facts label

Nutritional food labels typically report serving sizes in both systems but only list metric values (g or mg) for the breakdown of individual nutrients.

## FPLA issues

Since 1992, the federal Fair Packaging and Labeling Act (FPLA) has required consumer goods to be labeled in both customary and metric units. Some industries are engaged in efforts to amend this law to allow manufacturers to use only metric labeling. Forty-eight U.S. states have adopted laws permitting labeling in only metric units, with the two exceptions being New York and Alabama. New York was reportedly examining a shift to allow metric labeling in 2008, but had not done so by 2009. According to the European Community (now the EU) Directive 80/181/EEC issued on December 20, 1979, the European Union would have only allowed dual-unit labels to appear on products until December 31, 2009, but problems experienced during metrication efforts in the UK forced the EU to abandon this deadline.

Pending the EU deadline, an amendment to the FPLA to allow metric-only labeling would allow manufacturers, both importers and exporters, to avoid the significant costs associated with having to produce two distinct types of package labels. A bill to permit metric-only labeling at the federal level was to have been introduced in 2005. Significant opposition from the Food Marketing Institute, representing U.S. grocers, has delayed the introduction of the bill. FMI expressed the fear that legislation to permit metric-only labels might also somehow mandate resizing of packaging to round metric sizes (a process already well underway), and this could require expensive remodeling or replacement of existing display cases. A compromise has been suggested whereby manufacturers in both the U.S. and the EU could opt for either metric-only or dual-unit labeling, but this idea has been viewed dimly by the EU negotiators.

## **Construction**

Out of all industries, construction has adopted metric units least. Dimensional lumber comes in standard nominal inch cross-section sizes (e.g., a 2-by-4 is really 1½ by 3½ inches). Lengths are given in feet. Building codes are established at the local level and the U.S. has extensive building standards that are based on customary units. Because of Canada's proximity to the U.S., issues of common units still arise. This tendency in construction is similar to Japan, an otherwise metricated country where traditional construction still uses Japanese units predating metrication.

## **Aviation**

Aircraft heights for air traffic control and related purposes are measured in feet in the U.S. In fact, most of the world has used feet for aviation altitudes since the end of WW2 (meters before 1945 in all European countries except the UK), with the notable exceptions of China, North Korea, Russia and many other CIS (former Soviet) countries. For instance, an airliner on a long flight, even if neither its starting point nor destination are in the United States, might use a nominal cruising altitude of, say, 36,000 feet, using an internationally standardized system of flight levels (technically Flight Level 360 in this case). In 2011 Russia switched from metric to foot-denominated flight levels at high altitude to eliminate the need for adjustments when crossing in or out of its airspace.

## **Education**

Most students are taught the metric system in elementary, middle, and high school. Instruction primarily centers on the concepts of powers of 10, the associated prefixes, and the conversion from one prefix form to another. Units of length, volume, and mass are typically introduced through comparison with ordinary objects. The metric system is not reinforced much outside the classroom due to lack of popular metric use. Consequently, while students may understand some of the concepts underlying the metric system, they do not necessarily have an intuitive sense of the value of the units.

In science education, students predominantly use metric measures in experiments and equations, allowing those interested in the sciences to become more familiar with the metric system. Science classes are requisites for an undergraduate degree in the U.S. which ensures most educated people have some familiarity with the metric system. Within higher education, the

metric system is universal for classes in the sciences (see below), with the exception of exercises designed to illustrate complex conversions. Some non-science textbooks in the U.S. use only the metric system without giving conversions in order to promote metrication.

## **Electricity and energy**

There are no U.S. customary units for electric current, potential difference, or charge since these concepts were developed after the international adoption of metric in science. The metric units ampere, volt, ohm and coulomb are the only units used. The SI term hertz has replaced the term *cycles per second* as a unit of frequency.

Energy is often measured in watt-hours, BTUs, therms or calories rather than the SI joule. Residential and commercial electrical energy use is metered and billed in kilowatt hours, kW·h. Fuel prices are mostly given in customary units, such as dollars per gallon, barrel, thousand cubic feet, or ton (short or long). Heating, cooling, and combustion are often measured in BTUs per hour or refrigeration tons and powerplant efficiency is often measured by its "heat rate", in BTU per kW·hour. The rated power of engines, electric motors, and power plant steam turbines is frequently measured in horsepower. Power plant output is generally expressed in megawatts.

## **Financial services**

The United States was one of the first nations to adopt a decimal currency. Until 2001, U.S. stocks were traded in fractions of dollars ( $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ ) based on the old Spanish pieces of eight, but the Securities and Exchange Commission ordered stocks to move to dollars and cents to better integrate with global markets. Some commodity market prices are quoted in customary units (such as barrels of oil, troy ounces of gold, pounds of frozen pork bellies, etc.). The federal government reports international production figures in metric units (for instance, wheat in metric tons) but in bushels for domestic production figures.

## **Firearms**

The U.S. uses both the inch and millimeter for caliber on civilian and law enforcement firearms.<sup>[23]</sup> Historically, rounds designed in the United States were denoted by their caliber in inches (e.g. .45 Colt and .270 Winchester.) Two developments changed this tradition: the large preponderance of different cartridges using an identical caliber and the international arms trade bringing metric calibers to the United States. The former led to bullet diameter (rather than caliber) often being used to describe rounds to differentiate otherwise relatively similar rounds. A good example is the .308 Winchester, which fires the same .30-caliber projectile as the .30-06 Springfield and the .300 Savage. Occasionally the caliber is just a number close to the diameter of the bullet, like the .220 Swift, .223 Remington and .222 Remington Magnum, all of which actually have .22 caliber or .224-inch-diameter (5.7 mm) bullets. The second development is actual metric calibers being introduced to the United States. 6 mm and 7 mm caliber rifles are particularly popular as are 9 mm and 10 mm caliber handguns. These metric caliber rounds are either described by their metric caliber, such as the very popular 7 mm Remington Magnum round or have their bullet diameter converted into inches, such as the also extremely popular .243 Winchester. Occasionally U.S.-designed inch-caliber rounds will be converted into metric

as well. The U.S. military, reflecting its need to ensure interoperability with its NATO allies, uses metric measurements for almost all weapons calibers, even when the caliber in question originated as or was derived from a different measurement (e.g., 7.62 mm rather than .308, or 5.56 mm instead of .223). Major handloading manuals in the U.S. however use U.S. customary units for all pertinent measurements including bullet diameter, cartridge overall length, powder charge weight, velocity, and maximum pressure, even with European-designed fully metric rounds.

## **Manufacturing**

Globalization of manufacturing has led to wide adoption of metric standards, although this is not yet universal. After a period where automobiles were assembled with both customary and metric fasteners in each vehicle, cars are now universally built with metric parts. Automobile engines, once named after their displacement in cubic inches, e.g., the 426 Hemi, are currently named after their rounded measurement in liters (e.g., the 6.1 L Hemi). Technical publications by industry publishers and American automakers often give engine displacements in cubic inches as well as cubic centimeters (which are equivalent to milliliters), or liters. For example, the specifications for the Dodge SRT-8 6.1 L Hemi state the displacement as 370 cubic inches (6,059 cc).<sup>1</sup>

The electronics and computer industries largely converted to metric standards as new technologies were introduced toward the end of the 20th century, also driven in part by a shift in manufacturing from the U.S. to countries in Asia with metric standards. Thus, while 5¼-inch floppy disks had a nominal package size of 5¼ inches (approximately 130 mm), the nominal design diameter of the replacement "3½ inch" disks was actually 90 mm. CDs and DVDs are 120 mm in diameter, but their size is rarely mentioned; Mini CDs are sometimes called *80 mm CDs*. Computer fan sizes are exclusively referred to by metric units (120 mm or 80 mm case fans, for example), while hard disk drive and CD drive bay widths are customary measurements, typically 3½ inches and 5¼ inches, respectively. Additionally, screen sizes are measured in inches, such as a 24-inch widescreen LCD display.

## **Military**

The U.S. military uses metric measurements extensively to ensure interoperability with allied forces, particularly NATO STANAGs, "standardization agreements". Ground forces measure distances in "klicks", slang for kilometers. Most military firearms are measured in metric units, beginning with the M-14 which was introduced in 1957, although a few legacy exceptions exist, such as .50-caliber guns. Aircraft ordnance is normally measured in pounds. Heavy weapon caliber is measured in millimeters. Military vehicles are generally built to metric standards. An exception is the U.S. Navy, whose guns are measured in inches and whose undersea fleet measures distances in terms of "kiloyards" (equivalent to 914.4 m), depth as "feet", and velocity, in some cases, as "feet per second". The Navy and Air Force continue to measure distance in nautical miles and speed in knots; these units are now accepted for use with SI by the BIPM

## Science and medicine

In science, metric use is essentially universal, consistent with worldwide use, although additional specialized units are often utilized for specific purposes in various disciplines (such as the parsec in astronomy). Medicine uses both U.S. customary units and metric units. The use of metric units for most other measurements has been widely accepted by healthcare professionals and patients. For example, medication doses are given in milligrams and milliliters and pediatric dosages given in terms of milligrams per kilogram. However, the sizes of pill containers are given in fluid drams. The exact metric unit used by healthcare professionals in the U.S. does occasionally vary compared to other countries. For example, U.S. diabetes patients measure their blood sugar levels in milligrams per deciliter, whereas most other countries use millimoles per liter. American blood glucose meters have the ability to switch between the two.

Earth sciences, such as hydrology and geology, continue to use customary units for field surveying. This due both to the legacy of many decades of data collection and to the need to work with the construction industry, which has not adopted the metric system.<sup>[citation needed]</sup> American irrigation engineers, for example, talk in acre-feet and cubic feet per second, whereas their Australian counterparts would refer to gegaliters and cubic meters per second.

Meteorology extensively uses both metric and customary units. The METAR reporting system in use in the United States differs from the one used by the World Meteorological Organization in that wind speeds are delivered in knots (instead of meters per second) and altimeter setting in the customary inches of mercury (instead of hectopascals). Furthermore, temperatures are reported in whole degrees Fahrenheit but are converted to Celsius when encoded in METAR reports. Most synoptic observation charts are expressed in SI units, with the exception of aforementioned wind speeds, which must be converted for the purposes of calculation. Public forecasts, however, are given almost exclusively in customary units (degrees Fahrenheit, inches of mercury, and for wind speeds, miles per hour).

Use among veterinarians varies, but because of the heavy emphasis on public interaction, animal weights (e.g., for cats or dogs) are nearly always recorded and reported in pounds and ounces. Usage at veterinary teaching hospitals, by contrast, favors the SI units.

In early 2007, NASA announced that it would use metric units for all operations on the lunar surface when it returns to the Moon, then projected for 2020. However NASA's lunar return program was canceled in 2010.

## Sports

U.S. citizens are frequently exposed to metric units through coverage of international sporting events, particularly the Olympic Games.

Races in the U.S. are usually run in metric distances (e.g., the 100 meter dash and 5 km (5K) races), although the mile distance remains popular. The marathon is referred to as a 26-mile (42 km) race (the official marathon standard distance originally being in English units – 26 miles, 385 yards) rather than 42.195 km.

Measured distances as used in events such as shot put, high jump, and discus throw are, however, often in feet and inches, except at the national and international levels. The field and court sizes for most popular team sports (even soccer) were originally set in non-metric units. This is reflected in American football, in which the playing field is divided into yards, and many important statistics are measured in yards. Similarly, the dimensions for all baseball parks, basketball courts, tennis courts and ice hockey rinks are given in feet, golf courses in yards, auto racing tracks in miles (or fractions thereof), and horse racing in an archaic customary unit, furlongs. Some sporting equipment, such as skis and poles, is sold in metric units. The lengths of automobile races in the U.S. are generally set in miles.

Bicycles, especially at the high end, are increasingly being sold and sized in metric (for example, a frame described as "21 inch" size in the past is now often labeled as a "53 cm" frame instead). Some bicycle wheels are labeled in metric as "700c" for a nominal 700 mm diameter road bike tire, but mountain bikes tend to use 26-inch wheels.

Common swimming pool dimensions are 25-yard, 25-meter, and 50-meter. High schools and the NCAA conduct 25-yard competitions. USA Swimming (USA-S) swims in both metric and non-metric pools

## Transportation[



 "Valencia Rd. Tucson. 500 m" on Interstate 19

Highway speed limits are posted in miles per hour and distances are largely displayed in miles, yards, or feet, although a few dual mile/km signs can be found, mostly left over from demonstration projects that are no longer supported. One exception is Interstate 19 in Arizona, which is almost completely signed in metric, except for speed limit signs. Signage on this road is, however, being converted back to customary units as they are replaced. Another exception is the turnpike section of Delaware Route 1, which uses a kilometer-based system, in anticipation of the mid-1990s conversion in the U.S. to the metric system (which did not happen). Distances were originally signed in kilometers, but have since been replaced with standard milemarkers. The exit signs have remained metric.

The 2000 and 2003 editions of the Manual on Uniform Traffic Control Devices were published using both metric and American Customary Units. Metric signs, including speed signs in kilometers per hour, were displayed in the manual even though they were not normally used on the roads and there was no definite plan to go metric. For visual distinction, regulatory and



advisory metric speed signs have black circles around the numbers followed by "km/h" and other regulatory metric signs have yellow plates reading "METRIC" in black on top of the main signs. Metric signs and metric measurements were removed for the 2009 edition and replaced with an appendix of metric conversion tables. Officially, this means that, although not widely used, metric road signs are *allowed* in the United States.

Newer signs on state highways on the island of Kauaʻi in Hawaiʻi also include distances in both miles and kilometers. Mile markers along highways on the Island of Hawaiʻi will indicate both units whenever the *whole* kilometer corresponds with the *whole* mile (ex.: 5 mi/8 km). In Houston, Texas many speed limits have km/h signs underneath the MPH signs. These are located near both airports and in the Texas Medical Center. The U.S. territory of Puerto Rico generally uses American-style (MUTCD) signs with metric measurement on highways, displaying kilometer posts and distances in km, yet speed limit signs are in miles per hour. The Maine Turnpike has metric measurements on its highway signs in addition to Customary measurements, partially to assist the large numbers of Canadian tourists who visit Maine's beaches.

Gasoline and diesel fuel are sold by the U.S. gallon, and fuel economy is rated in miles per gallon (MPG). Stations in Point Roberts, Washington, a short, discontinuous peninsula that is accessible to the rest of the state of Washington only by crossing into Canada, sells its gasoline from pumps calibrated to dispense in liters. Gasoline is dispensed in liters in Puerto Rico. Automobile crankcase oil is sold by the quart, antifreeze by the gallon, brake fluid by the ounce (fluid), and A/C refrigerant by the ounce (mass). Windshield wiper replacement blades are measured in inches.

Domestic airline flights are assigned altitudes in feet and measure speed in knots. Nautical charts show depth in fathoms and use the nautical mile for distance. (One minute of arc of latitude at the radius of the earth at sea level was the standard for one nautical mile until ca. 1929. The nautical mile is now defined as exactly 1,852 meters.) Railroads use the standard gauge of 4 feet 8½ inches, as does most of Europe (where it is expressed instead as 1,435 mm). U.S. Federal Motor Vehicle Safety Standard 101, which governs vehicle controls and displays, permit speedometers to display miles per hour, kilometers per hour, or both. Odometers are permitted to record miles or kilometers, but must be clearly labeled as to which unit they record. In practice, virtually all U.S.-market vehicles have mile odometers and dual labeled speedometers with mile-per-hour as the primary calibration. Some vehicles with electronic speed and distance readouts can be switched between U.S. and metric units.